

Through-body capacitive touch communication

[Hoang Truong](#), Phuc Nguyen, Viet Nguyen, Mohamed Ibrahim,
Richard Howard, Marco Gruteser, Tam Vu



University of Colorado
Boulder

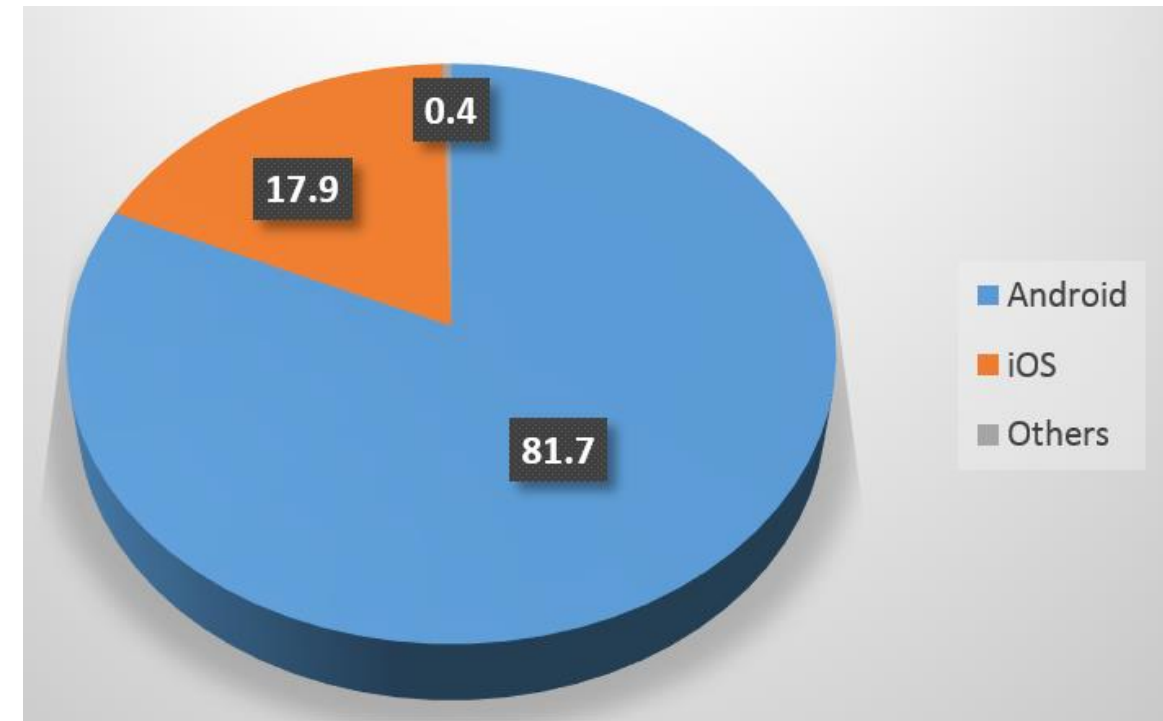


Do you have smart devices?

*Total number (billions)



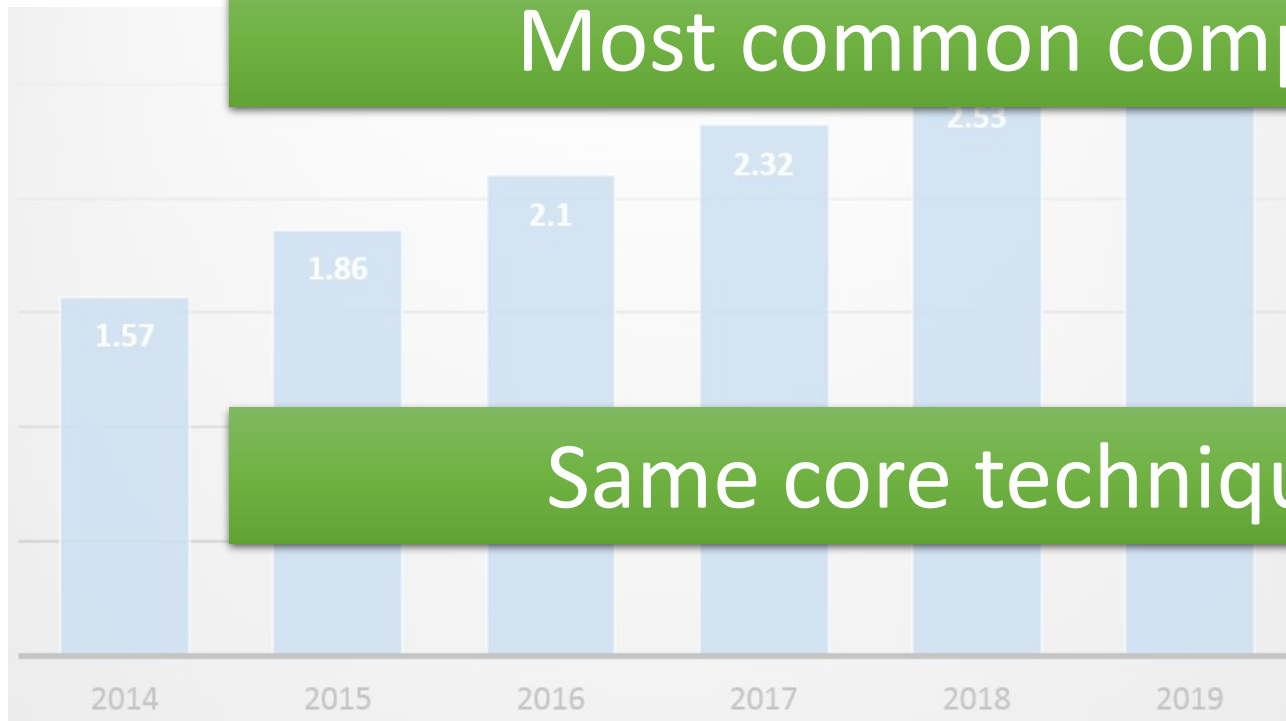
*Device type distribution



**Statista and TheVerge statistic*

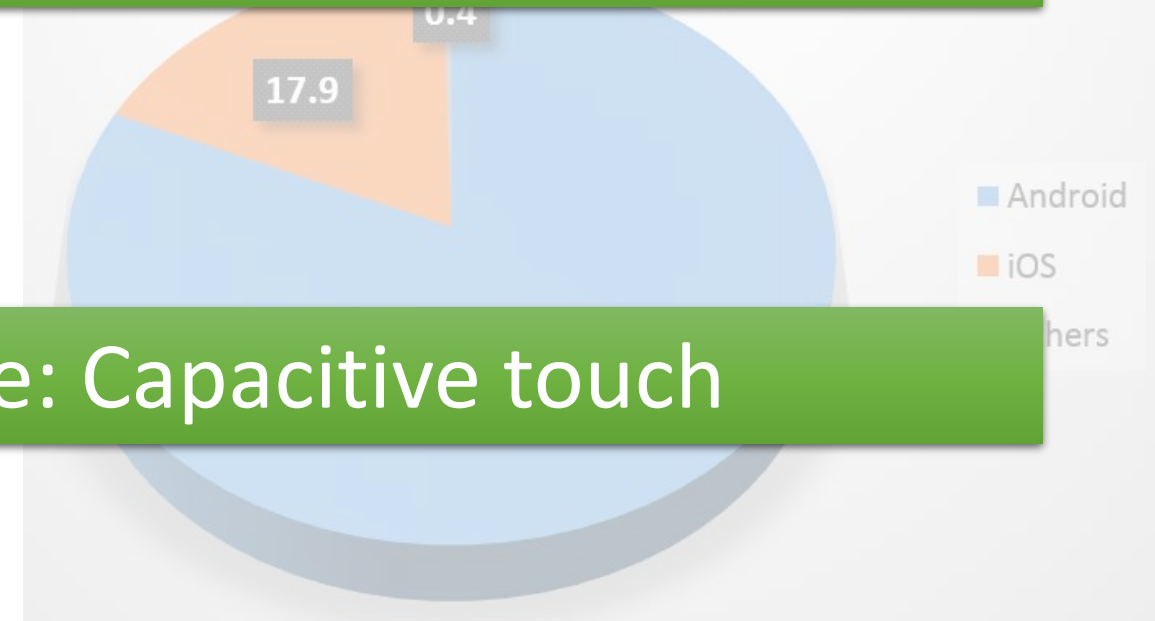
Do you have smart devices?

Total number (billions)



Most common component: Touchscreen

Device type distribution



Same core technique: Capacitive touch

How do you unlock them securely?

*More than 80 times per day

Pin code



Cumbersome

Touch ID



Need at least 2 touches

Face ID



Not there yet

**Apple report*

Shared devices / Collaborative works



Shared devices



What can be the most simple and intuitive unlocking?



How to save our time for this authentication process?

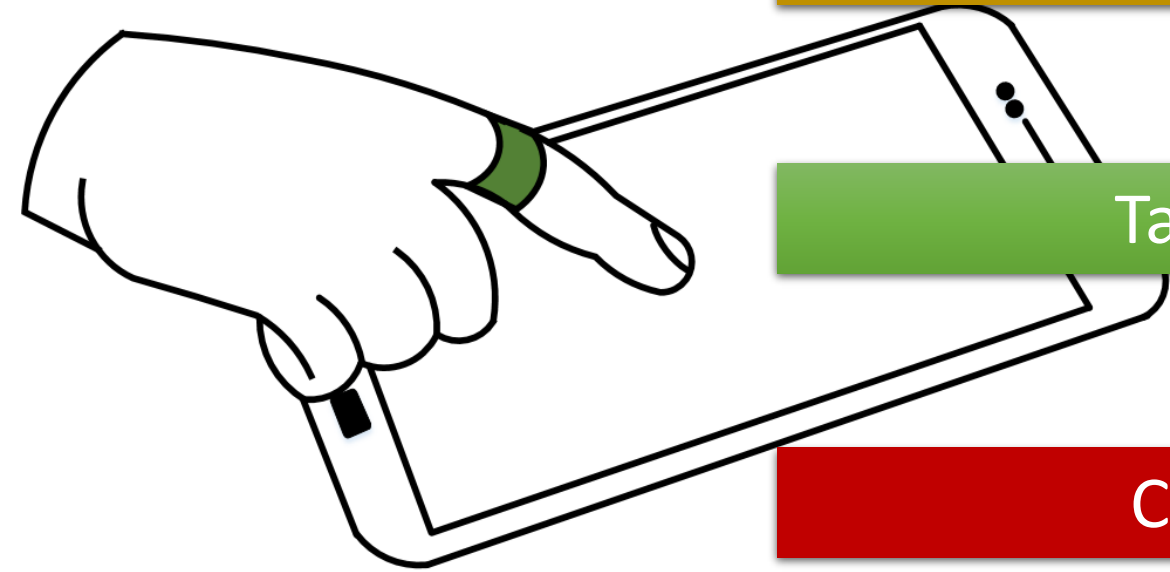


Idea: Per-touch authentication

Integrate authentication data into touches

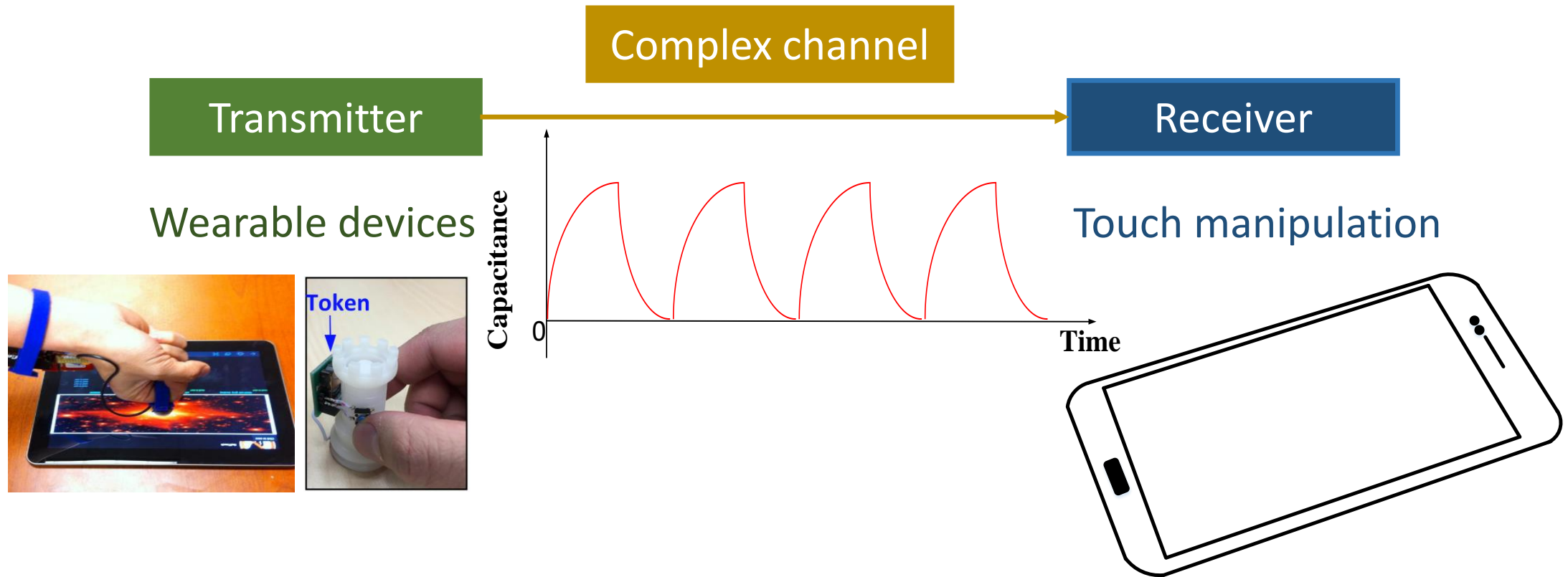
Target billions of touch interfaces

Capacitive touch communication



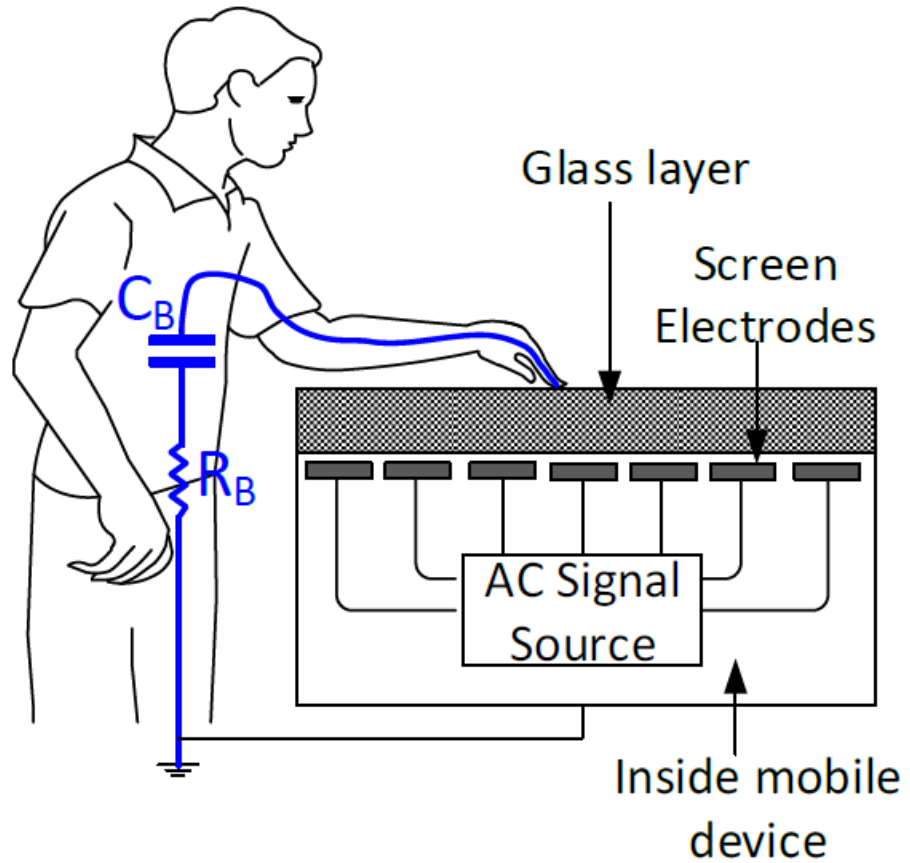
Capacitive touch communication

Concept was introduced in 2012

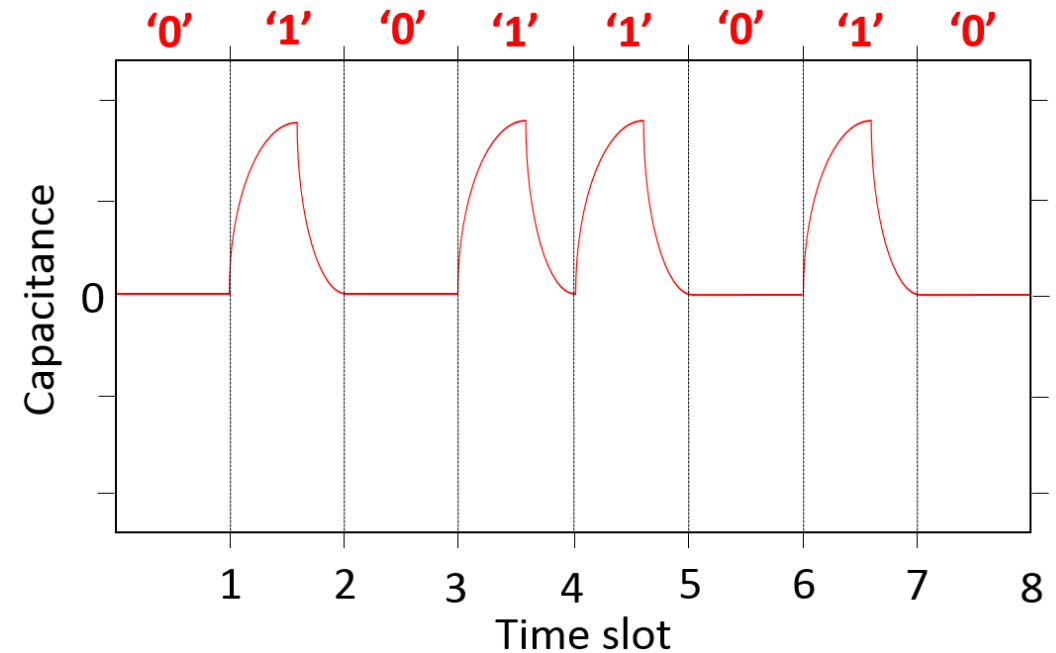


Touchscreen spoofing

Create "artificial" touches



Measure capacitance changes



Control capacitance change

Cap.Touch evolution

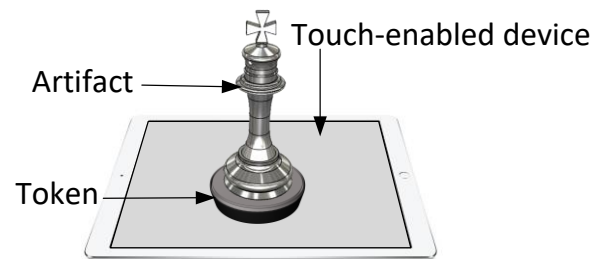
Hard surface in contact with screen

- Introduce concept of CTC
- Electrical pulse injection
- User identification



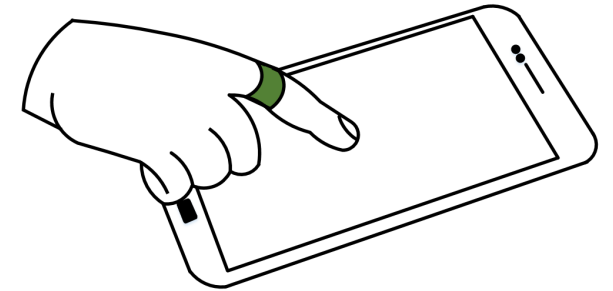
MOBICOM '12

- Object interaction
- Capacitance variation
- Object authentication



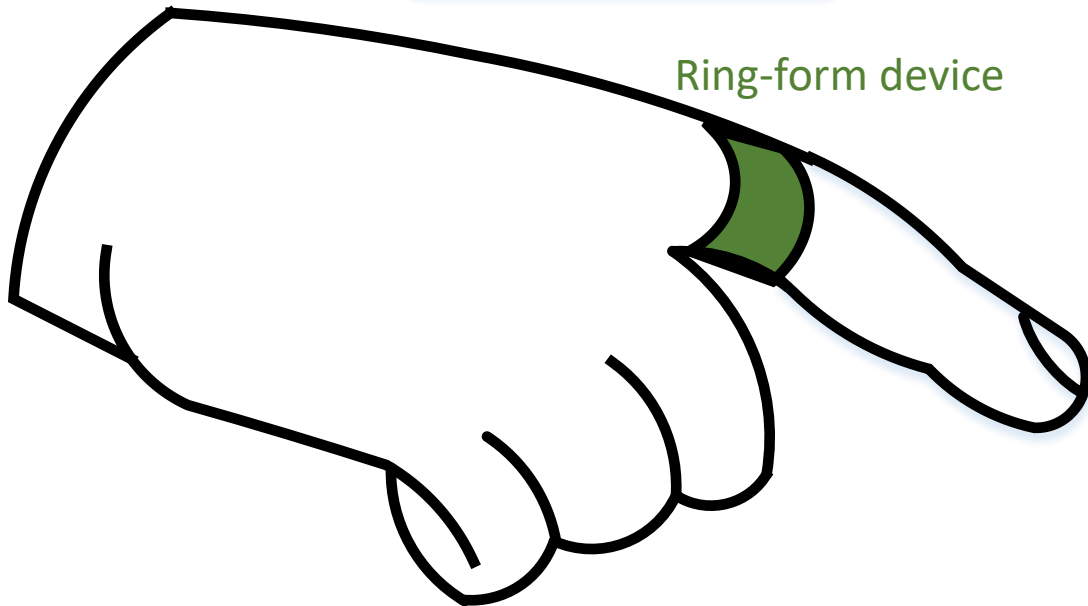
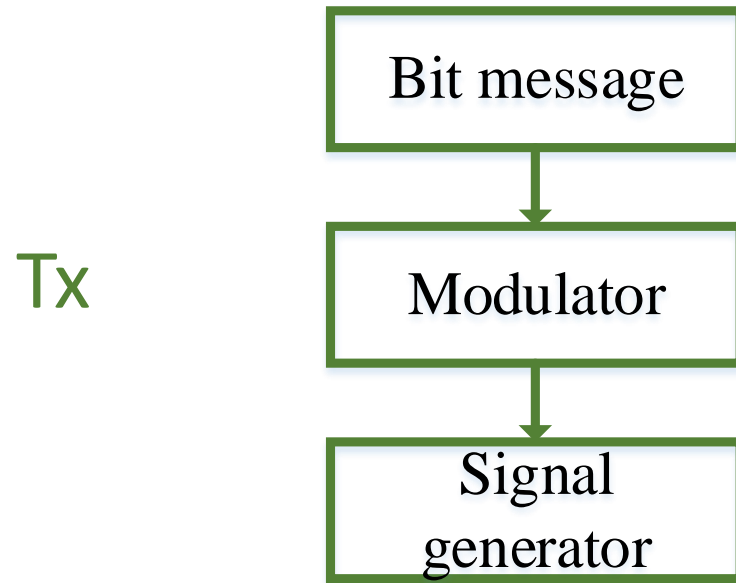
SENSYS '16

- Through-body cap.touch
- Per-touch authentication



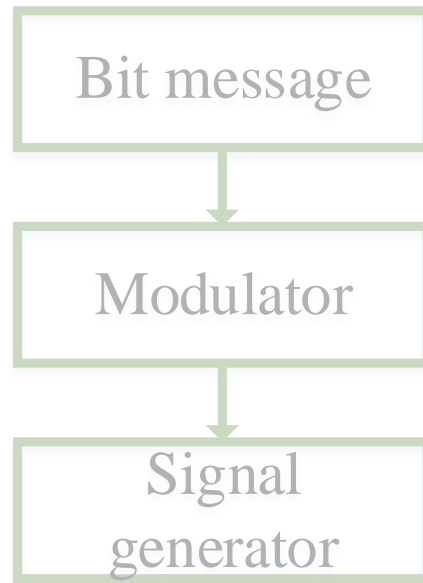
New approach

Through-body System

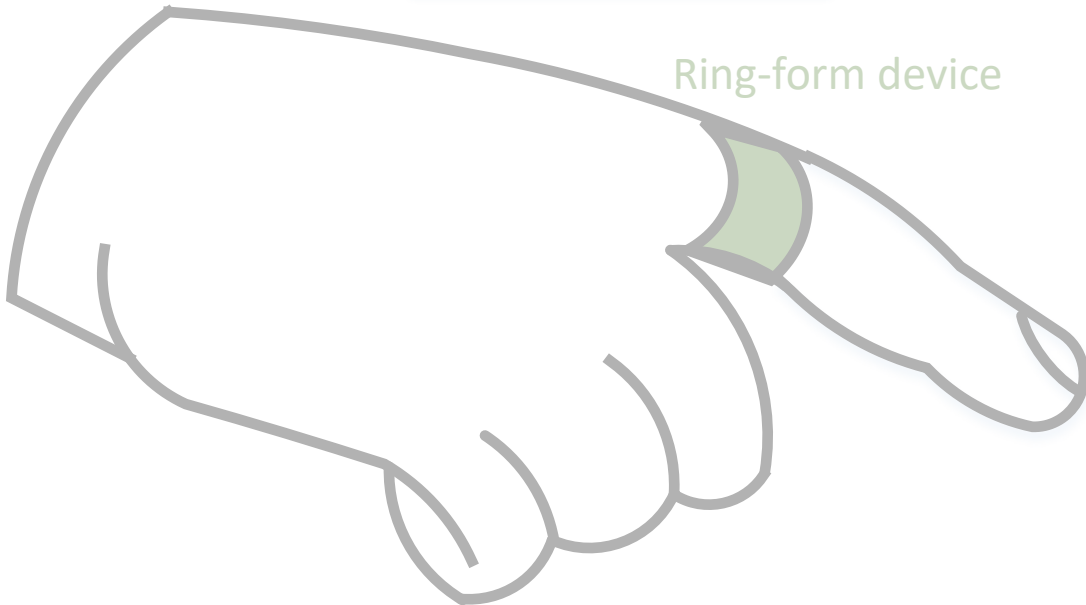


Through-body System

Tx



Ring-form device

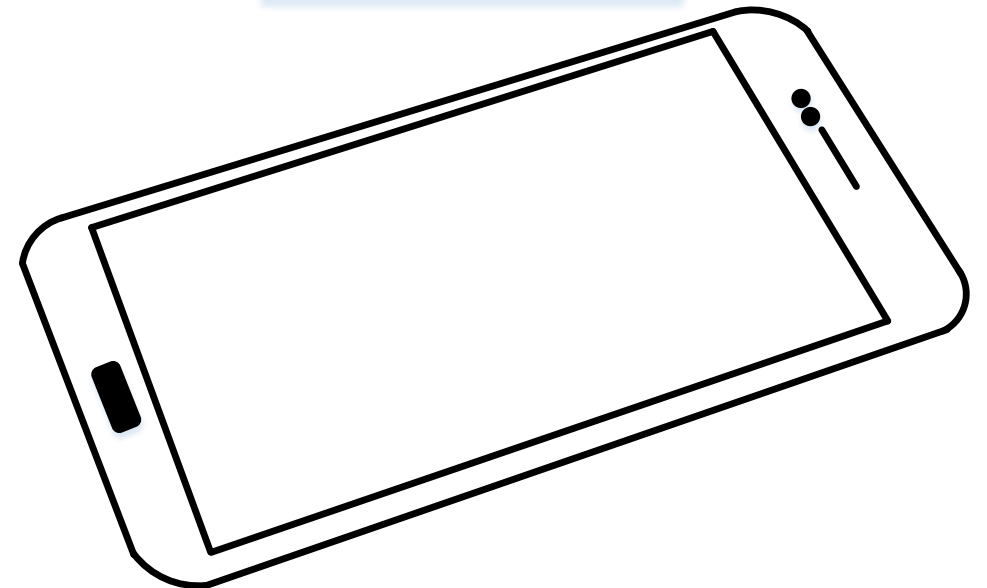


Touch event
detection

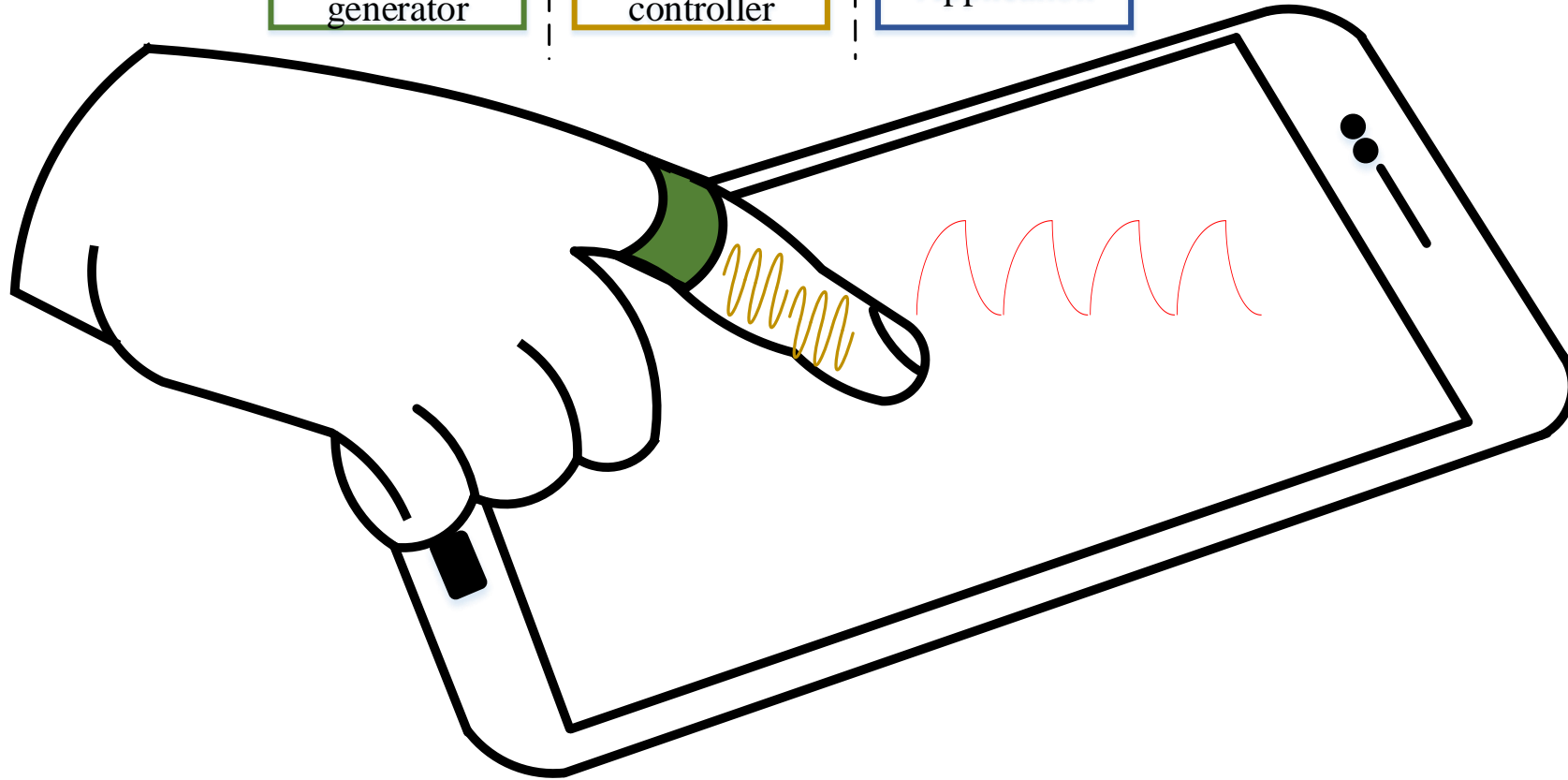
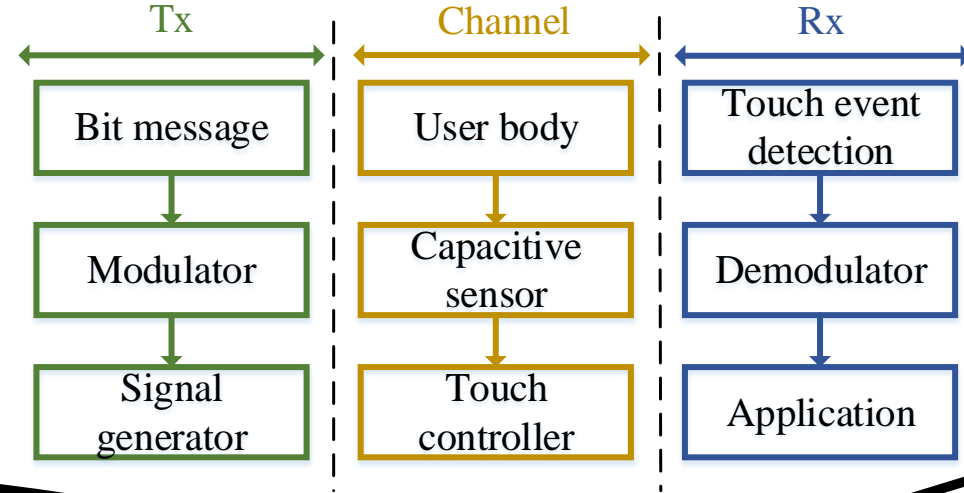
Demodulator

Application

Rx



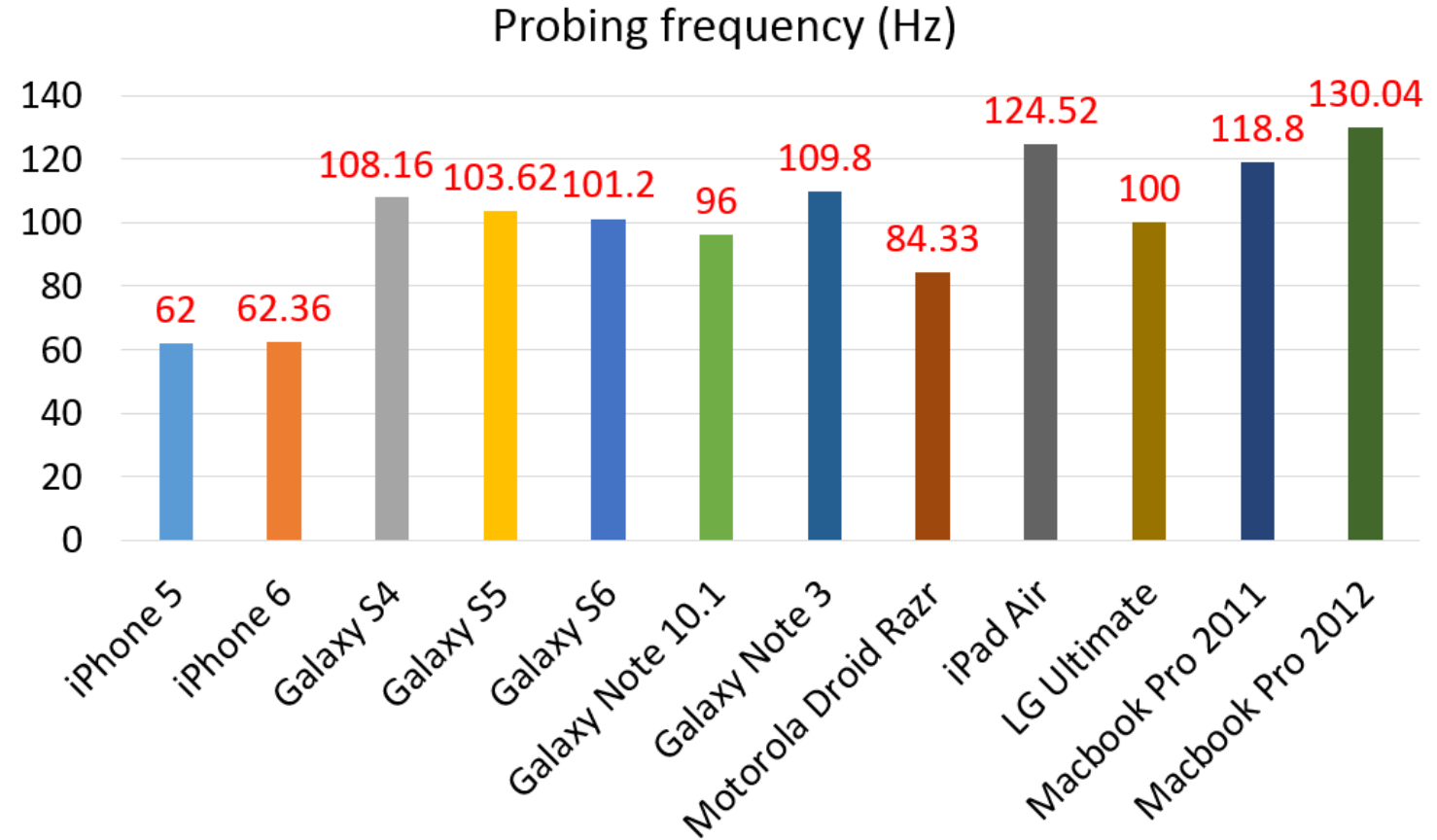
Through-body System



Challenge: Constrain with off-the-shelf devices

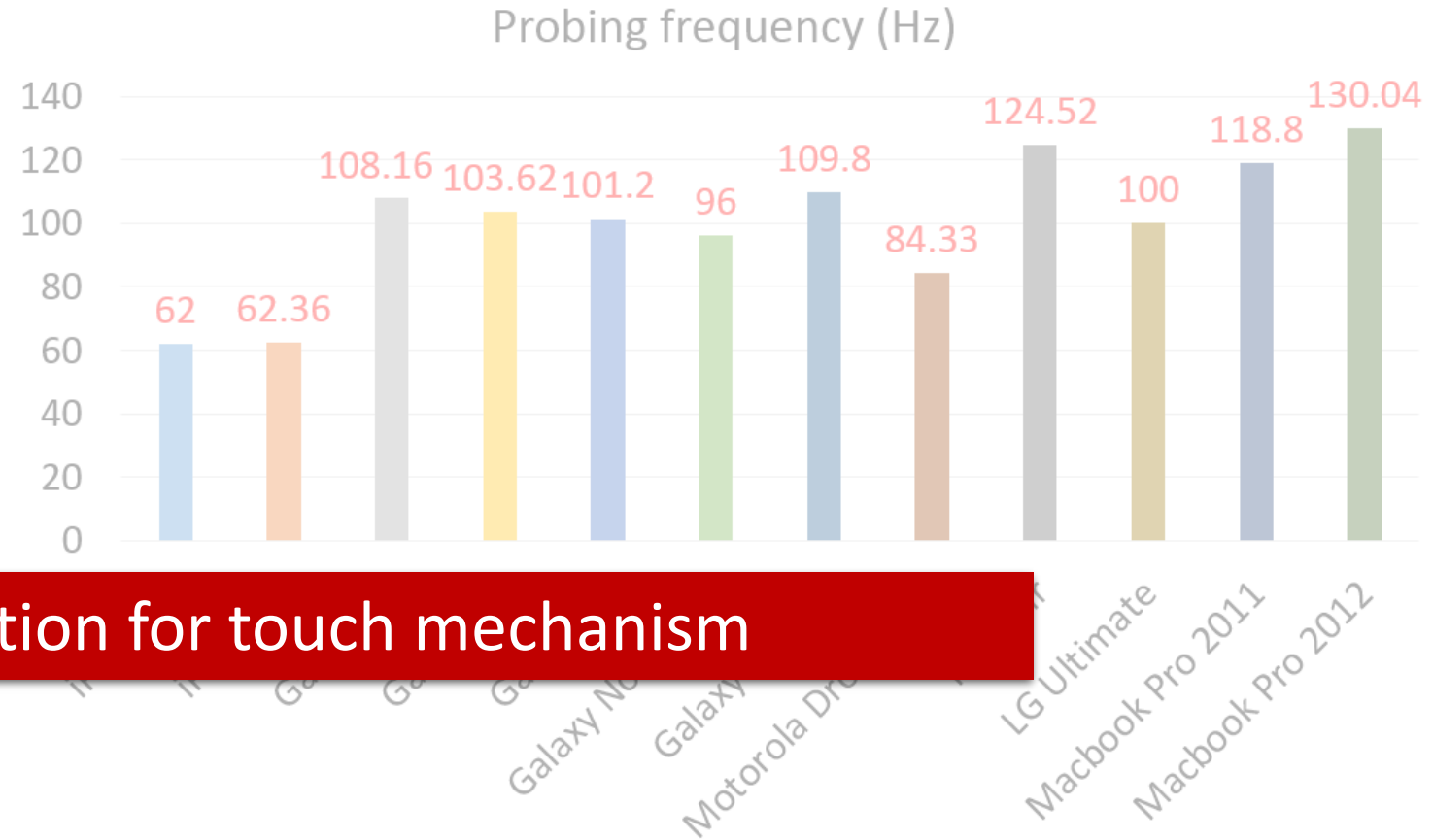
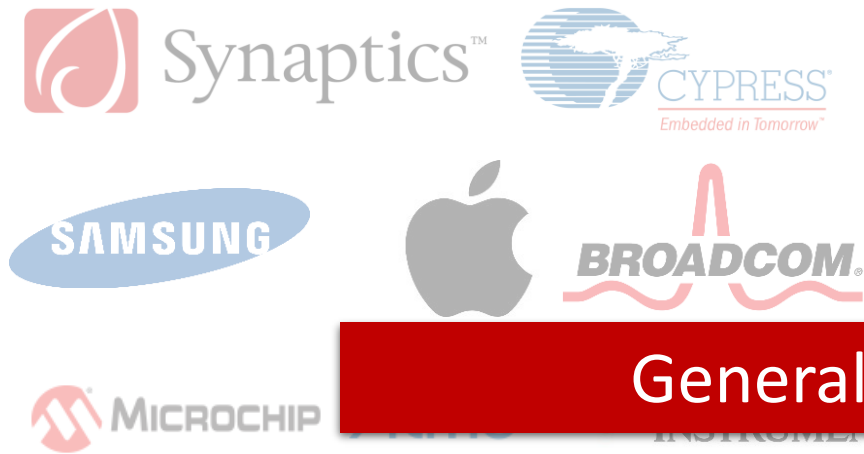


Diversity touch ICs & mechanisms



*Diversity touch scanning rates

Challenge: Constrain with off-the-shelf devices

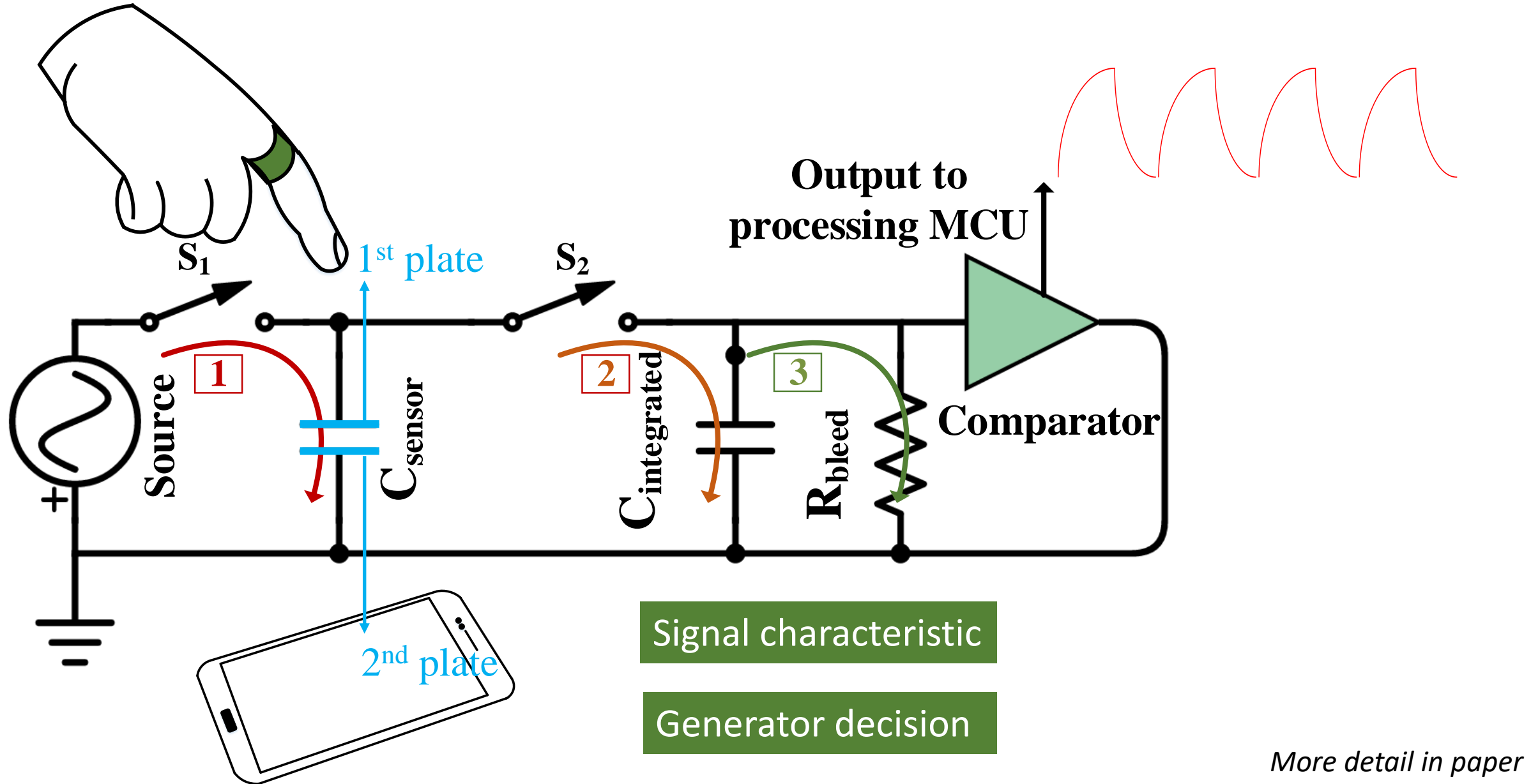


Generalization for touch mechanism

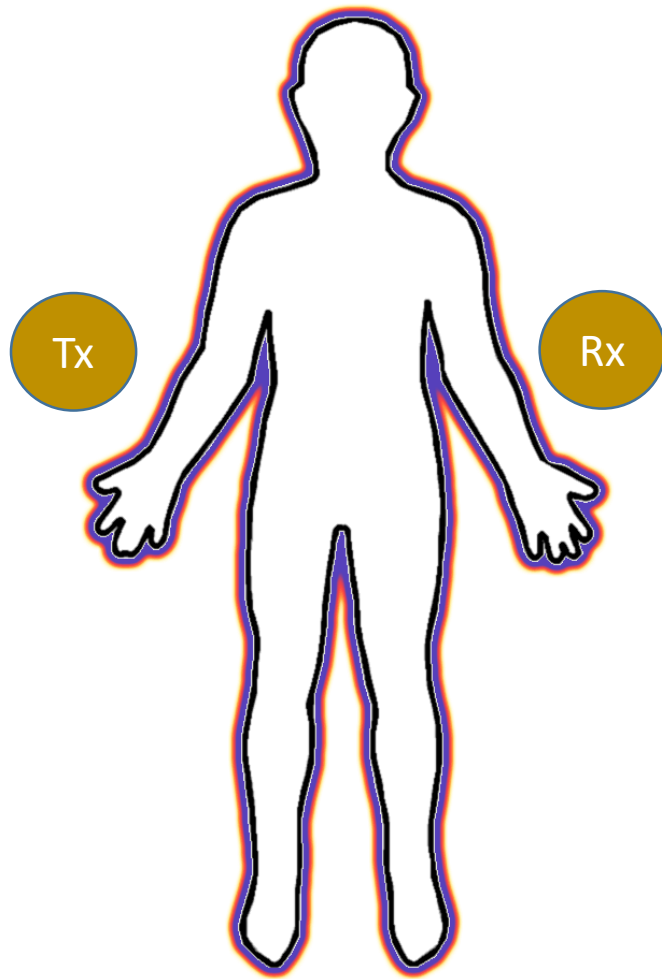
Diversity touch ICs & mechanisms

Diversity touch scanning rates

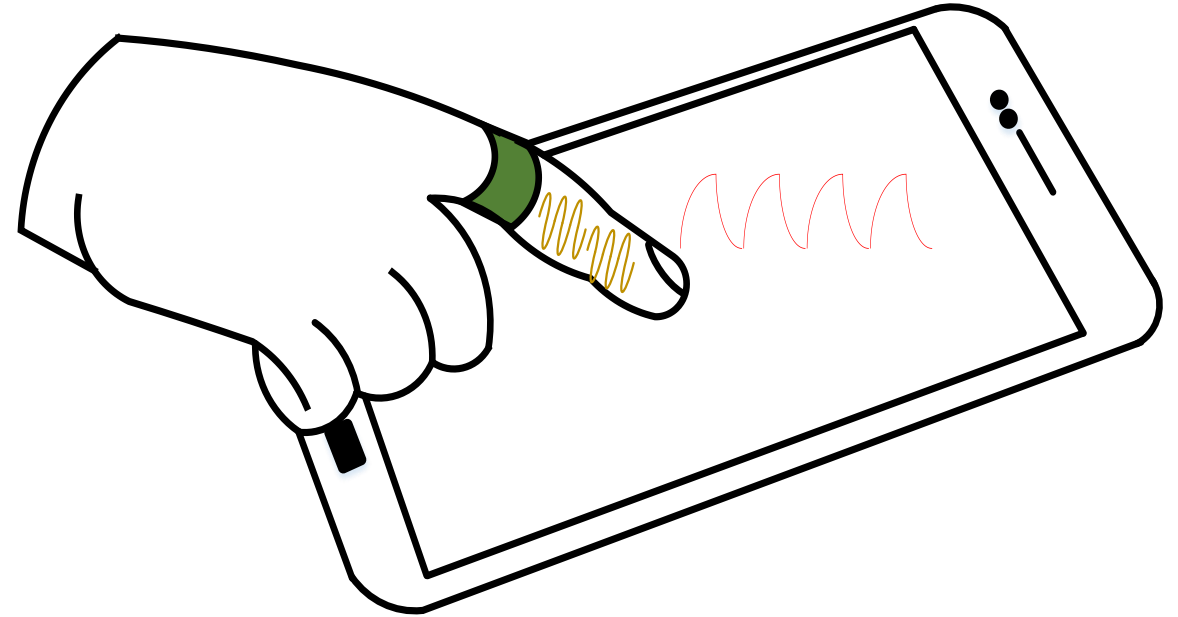
Approach: General model for touch mechanism



Challenge: Unpredictable intrabody channel

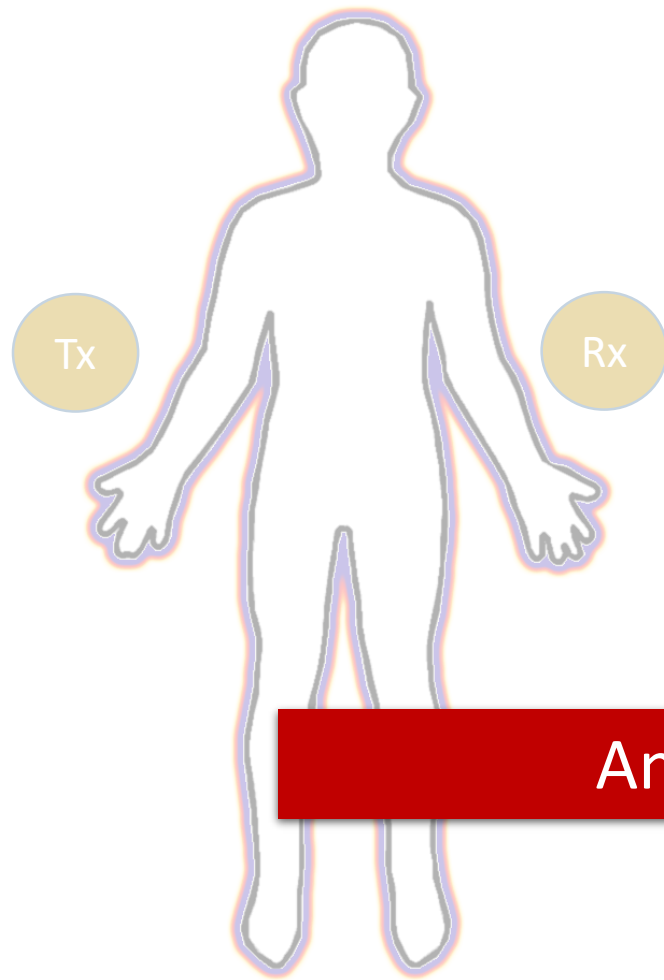


Traditional intrabody channel

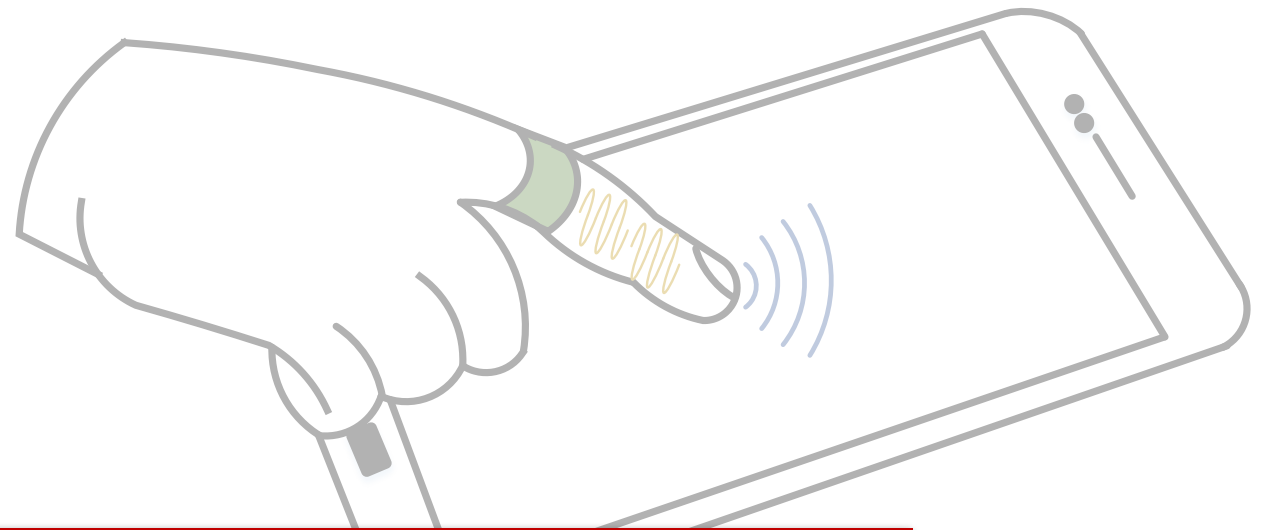


Smaller portion of body part
Significant role of touch device

Challenge: Unpredictable intrabody channel



Traditional intrabody channel

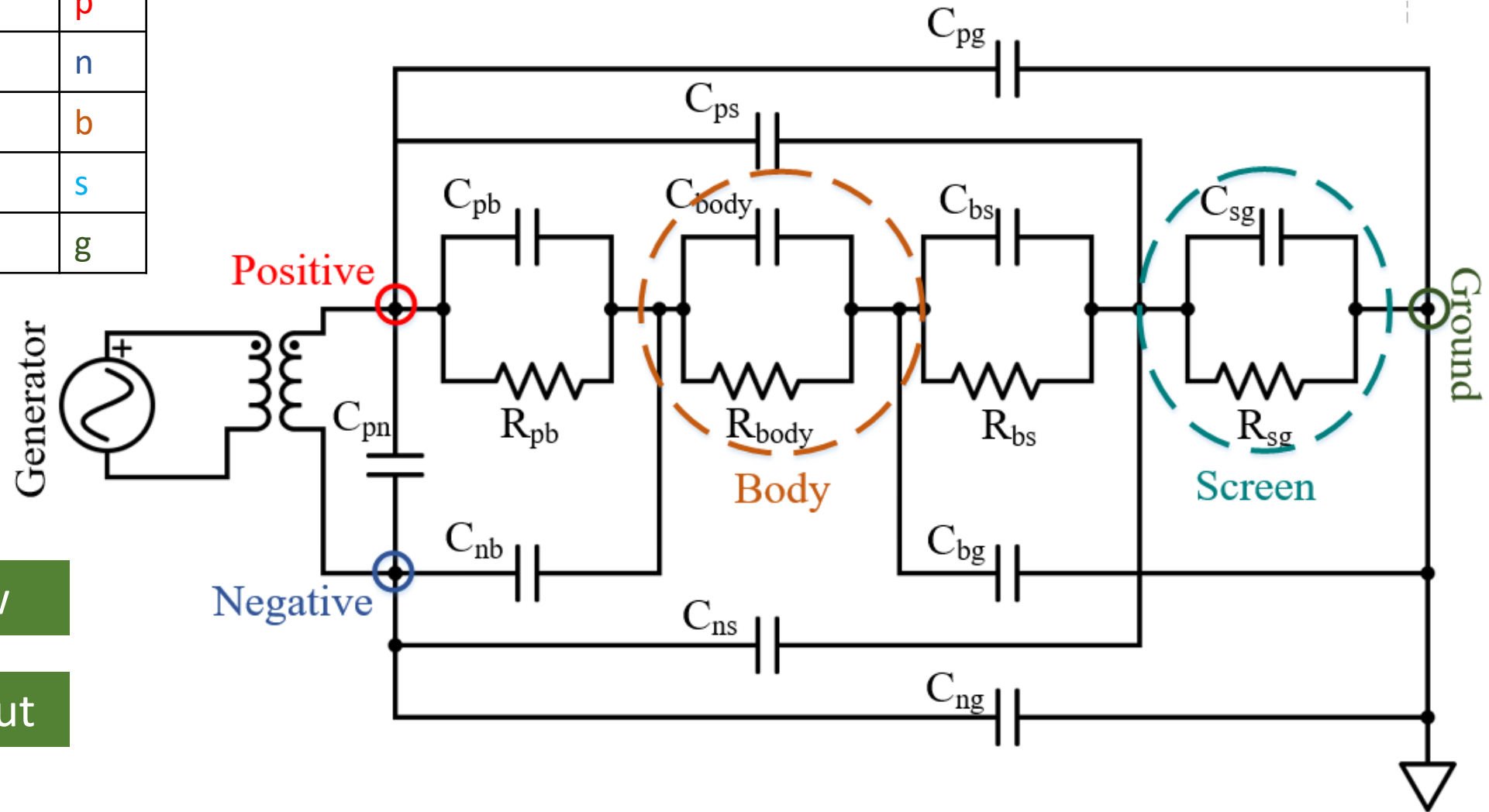


Smaller portion of body part
Significant presence of touch device

Analysis for system model in detail

Approach: Detail capacitive coupling circuit model

Positive electrode	p
Negative electrode	n
Body	b
Screen	s
Real ground	g



Predict signal flow

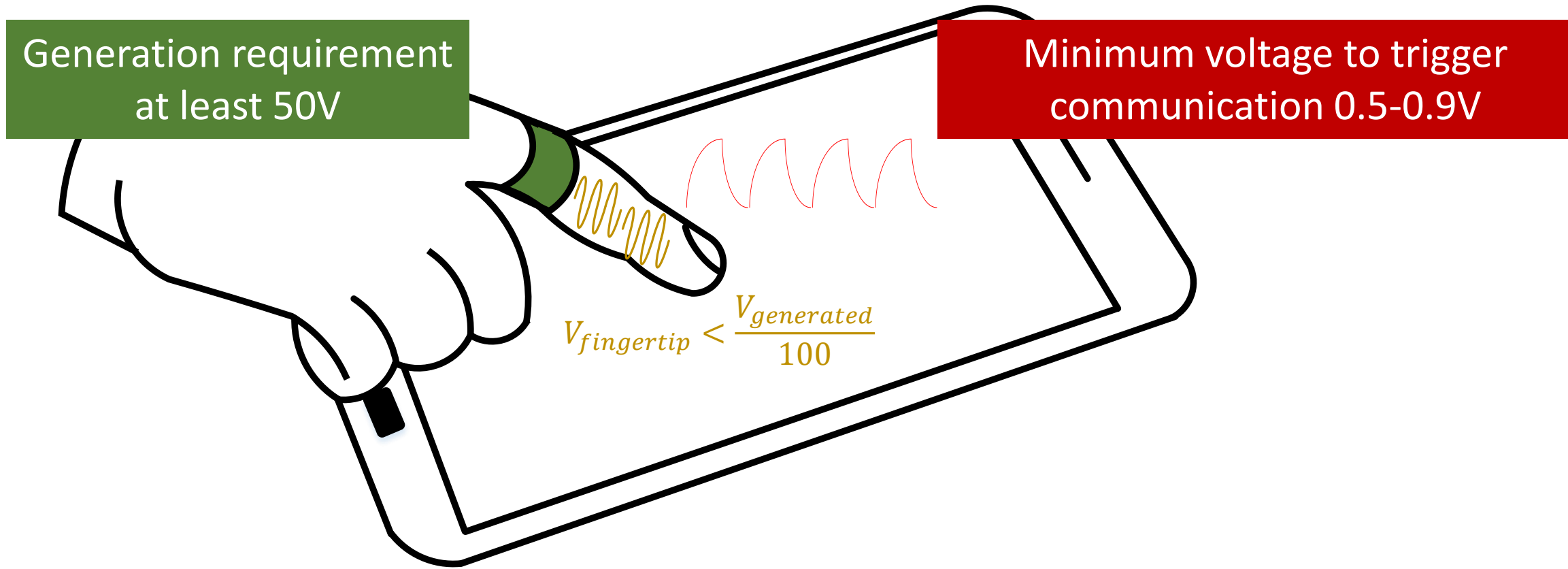
Predict signal output

More detail in paper

Prelim Evaluation: Encoding

Generation requirement
at least 50V

Minimum voltage to trigger
communication 0.5-0.9V

$$V_{fingertip} < \frac{V_{generated}}{100}$$
A diagram showing a hand holding a pen over a tablet. The pen has a green grip and a yellow spring-like tip. A yellow waveform is shown at the tip of the pen, and a red waveform is shown on the tablet surface. A formula is written below the pen tip.

Prelim Evaluation: Encoding

Generate high input voltage 50-240V

Generation requirement
at least 50V

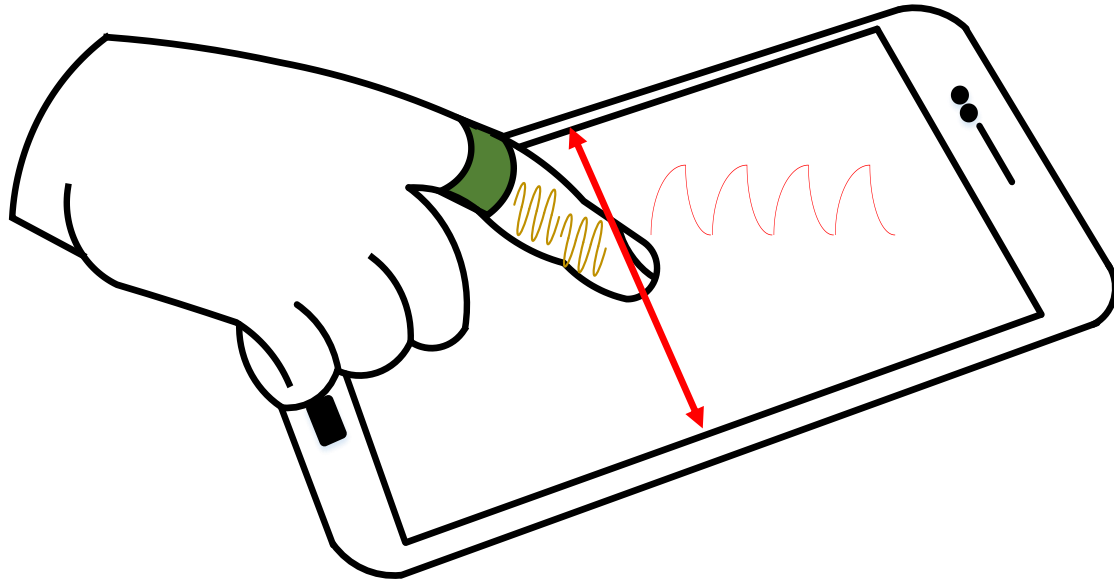
Minimum voltage to trigger
communication 0.5-0.9V

SAFE due to low current <1mA

$$V_{fingertip} < \frac{V_{generated}}{100}$$

Encode data by switching signal generator

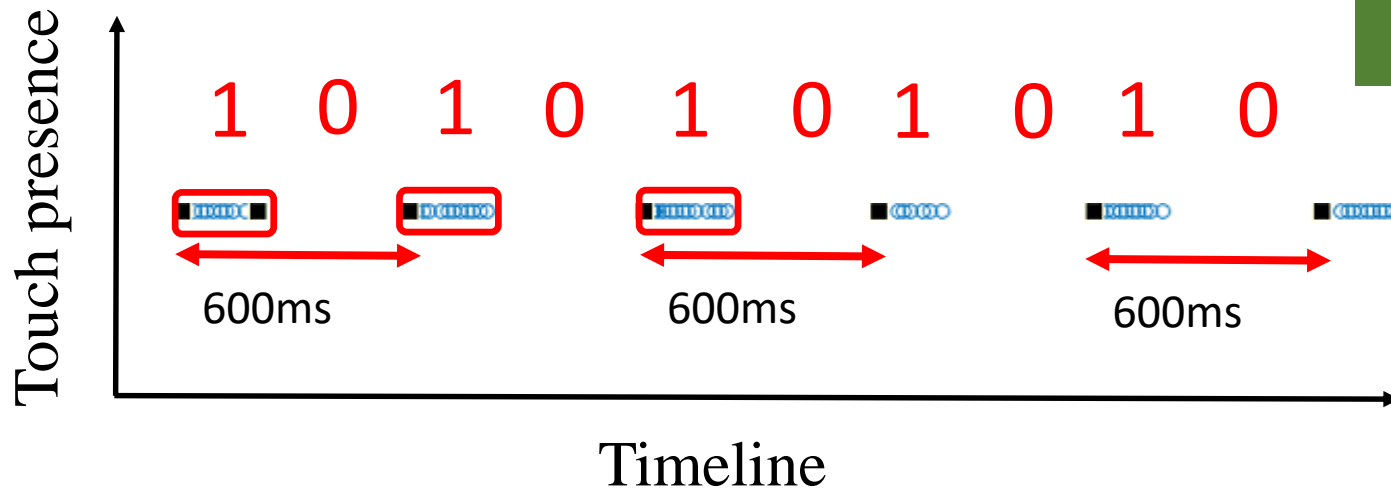
Prelim Evaluation: Decoding



Touches appear along horizontal grid

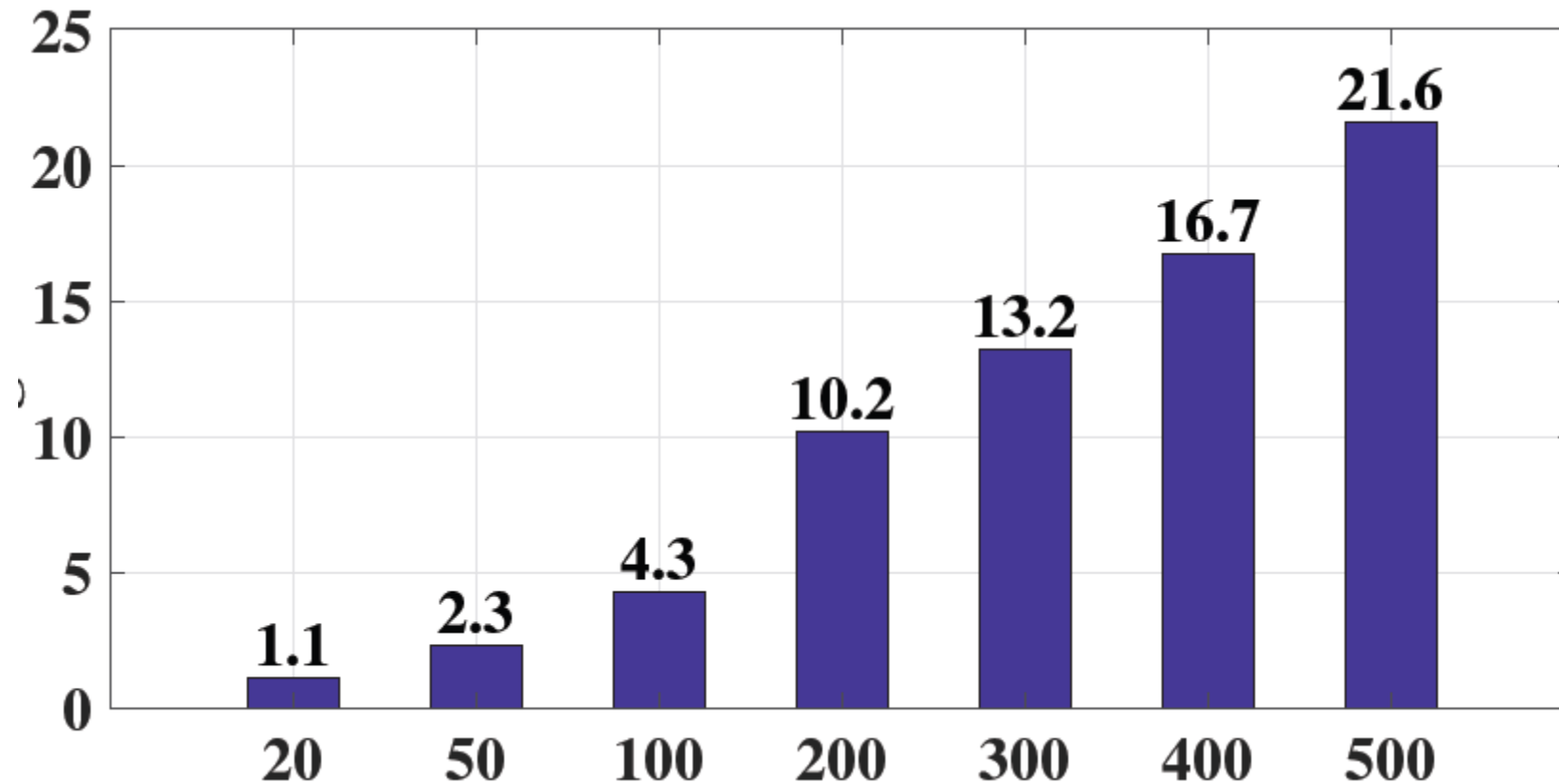
Recover original bit stream based on touch event manipulation

Valid feasibility of through-body scheme



More detail in paper

Average event numbers vs. Signal duration (ms)



Smallest touch interval = 17ms

Limitation due to off-the-shelf devices

Future work

Data rate incensement

Per-touch authentication deployment

Hardware/software optimization

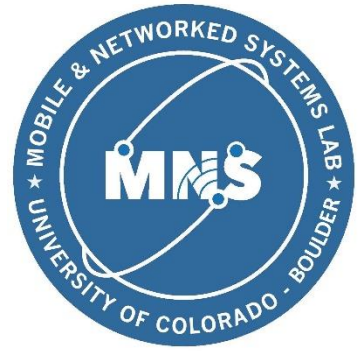
Conclusion

Propose new approach for CTC

Tackle challenges

Valid feasibility of
through-body CTC





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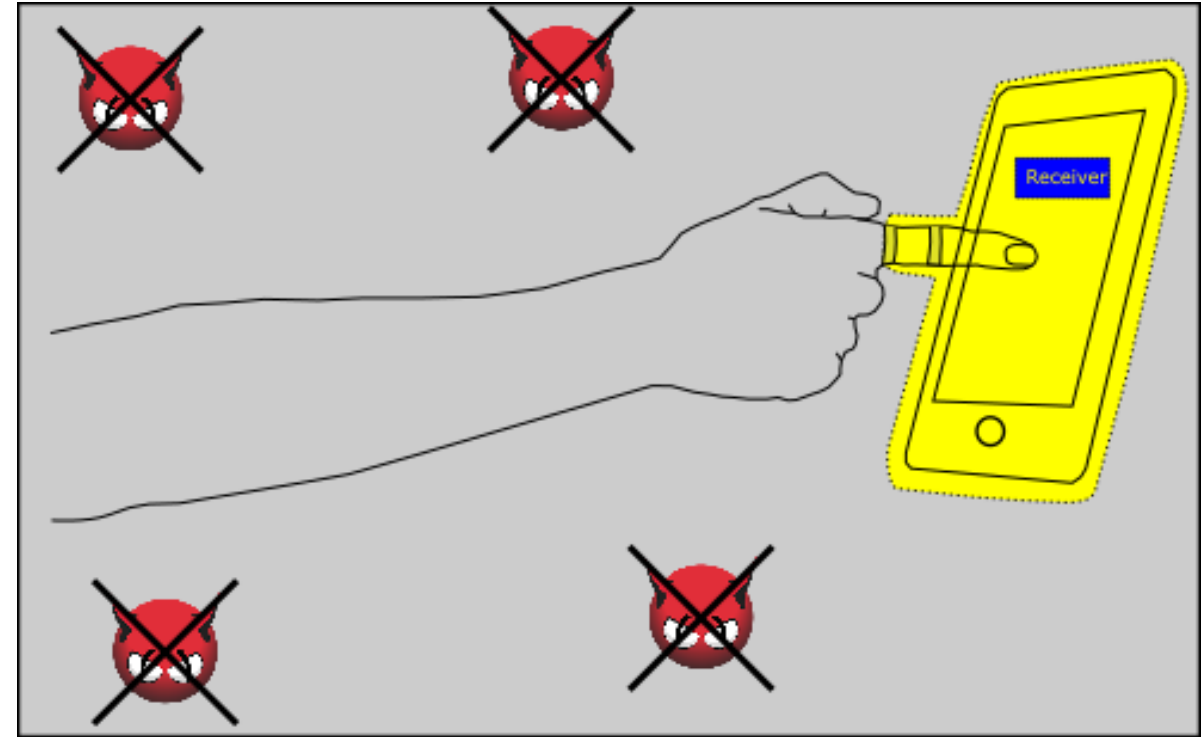
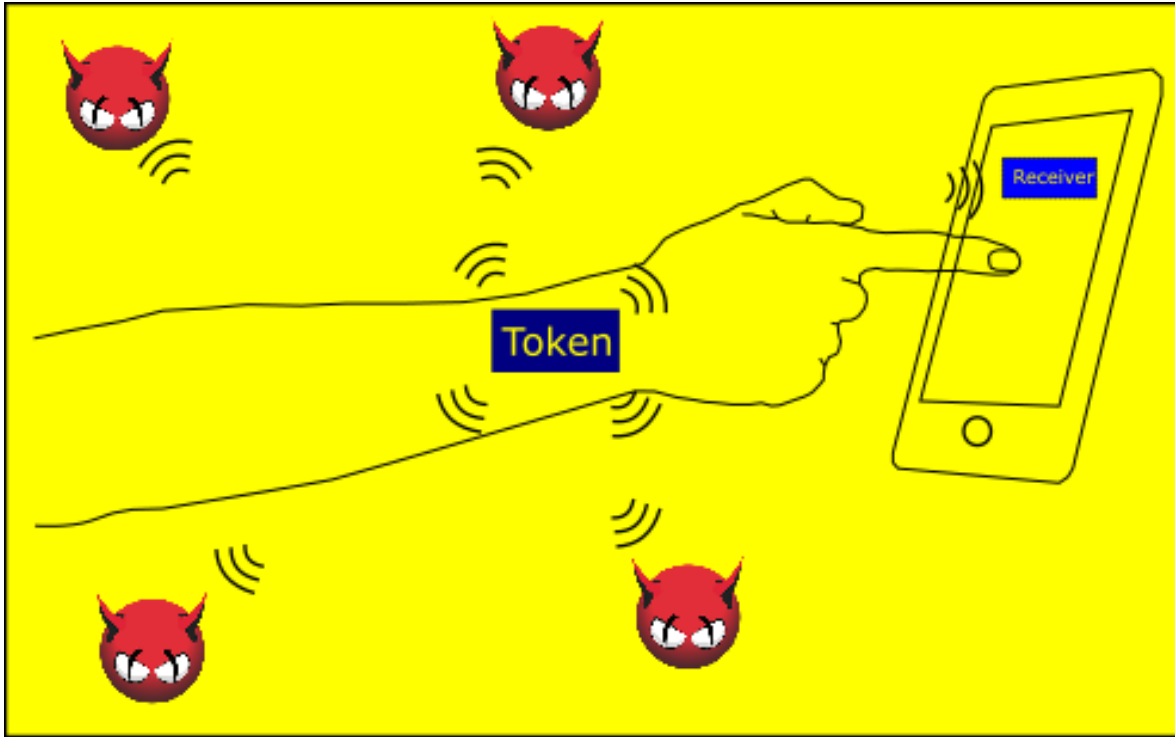
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One more thing ...



Potential security advantage